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ABSTRACT

Early child phonology was studied using phonetically transcribed samples that six parents provided of their children's vocalizations, beginning when the children were about 11 months old and continuing to four years of age. The primary study objective was to obtain a sufficient amount of longitudinal data from several children to support a detailed charting of early phonological development. Over 30,000 utterances have been collected and tabulated. Analyses are provided on onset and acquisition of multiple-word utterances, acquisition of phonological features, metathesis, and anomalous sound changes. Computer-assisted data analysis was undertaken, and the stored linguistic information incorporates details on initial and final consonants and consonant clusters, tags marking each utterance for reduplication, assimilation, metathesis, intervocalic consonants, "strange" vowels, and phrase context. Two phonological studies were conducted from this computerized data to investigate how one child acquired /stop + liquid/ clusters in initial word position. These studies seek to clarify the interaction between how often a sound is used in spontaneous speech and how it is phonetically realized. The preliminary studies suggest that during the overall acquisition process, each initial consonant and consonant cluster individually moves from one acquisition stage to the next. They may or may not be synchronized and occur either within or between natural consonant classes. (SW)

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STUDIES OF EARLY CHILD PHONOLOGY: DATA COLLECTION AND PRELIMINARY ANALYSES

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Systematic research of children's early phonological development during the ages of one to four years has proceeded quite slowly. The relative lack of research during this critical period of development is largely circumstantial. The essential difficulties are the inaccessibility to adequate quantities of representative speech samples for study between the ages of one to four years and the near impossibility of conducting controlled, experimental research with children under three or four years of age.

During the first year of life when infants are immobile, their babblings are readily accessible through tape recording and other forms of reproduction; hence, the mass of research during this period. However, with the onset of the first words around the first birthday, also comes walking, and stationary recording devices are soon left behind. "Talking" for the next seven or eight months is confined to single-word utterances, vocabulary development is relatively small, and daily verbal output ranges from five to perhaps thirty or forty meaningful utterances, and these are likely to be scattered throughout all hours of the day and night. Additionally, most of the toddler's utterances are unintelligible without knowing the situational context in which they occur. For example, "da" might mean "daddy, bottle, top," etc., or, perhaps, nothing at all. Thus, even by resorting to such extremes as tape recording everything the child says "around the clock," one would never know, only by listening, if the child was looking at his father or reaching for his bottle or top when he said "da," or if he was simply engaging in vocal gymnastics.

Consequently, there appears to be no substitute for the human observer. This additional constraint, along with those previously outlined, essentially restricts the collection of linguistic data on the toddler to observers capable of making unbiased behavioral and environmental observations in conjunction with detailed phonetic transcriptions, as the child speaks. Further, the observer must be familiar to the household, and the results of the present studies indicate the observer must spend a minimum of three to four hours a day, several days a week throughout the child's second year; at least, this amount of sampling is necessary to obtain a sufficient quantity of data to support an analysis of the evolving sound system. These demands of both time and training practically limit the potential observer to a willing and unbiased parent with some background in child development and linguistics. These are exactly the qualifications which were met by the parent observers who participated in the present research program.

Six parents have phonetically transcribed samples of their children's vocalizations, beginning when their children were about 11 months old (just prior to the onset of meaningful speech) and continuing to four years of age. Each parent's transcriptions were recorded in a small, easily carried note-

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book resembling a sort of running diary. To guarantee the samples were truly representative, the transcriptions were done at least four days a week and scattered throughout the child's waking hours, covering about 4 hrs. a day. Further, all transcriptions were made on-the-spot whenever the child happened to talk, and great care was taken not to interrupt the routine of daily living. Thus, the parents were just as free to record their children's speech at the supermarket, doctor's office, or playground as at home during such activities as bathing, meals, or household chores.

To insure consistency in transcribing their child's speech, each parent was trained to make accurate and reliable speech discriminations and to use the same system of phonetic notation. As a further precaution to maximize transcription reliability, I also made frequent home visits to crosscheck my independent transcriptions with those of the parents. Later, when the children began to talk more often, periodic tape recordings were done, and these were transcribed by myself and the parent to check for agreement. These reliability checks indicated a high agreement of the phonetic transcriptions and, particularly, for the consonants (approximately 90%) which are the primary focus of this research.

One primary objective of this research was to obtain a sufficient amount of longitudinal data from several children to support a detailed charting of early phonological development. To date, over 30,000 utterances have been collected and tabulated. To my knowledge, this data constitutes the most systematic and comprehensive speech sample ever compiled during this period of childhood (1 to 4 yrs.). Each utterance has been typed in phonetics along with the corresponding translation. To facilitate the analyses, the transcripts have been organized by child, and each utterance was assigned an identifying number, according to the date it occurred and the age of the child. Preliminary analyses of this data have been completed, and several of the results are summarized in this report.

ANALYSES AND RESULTS

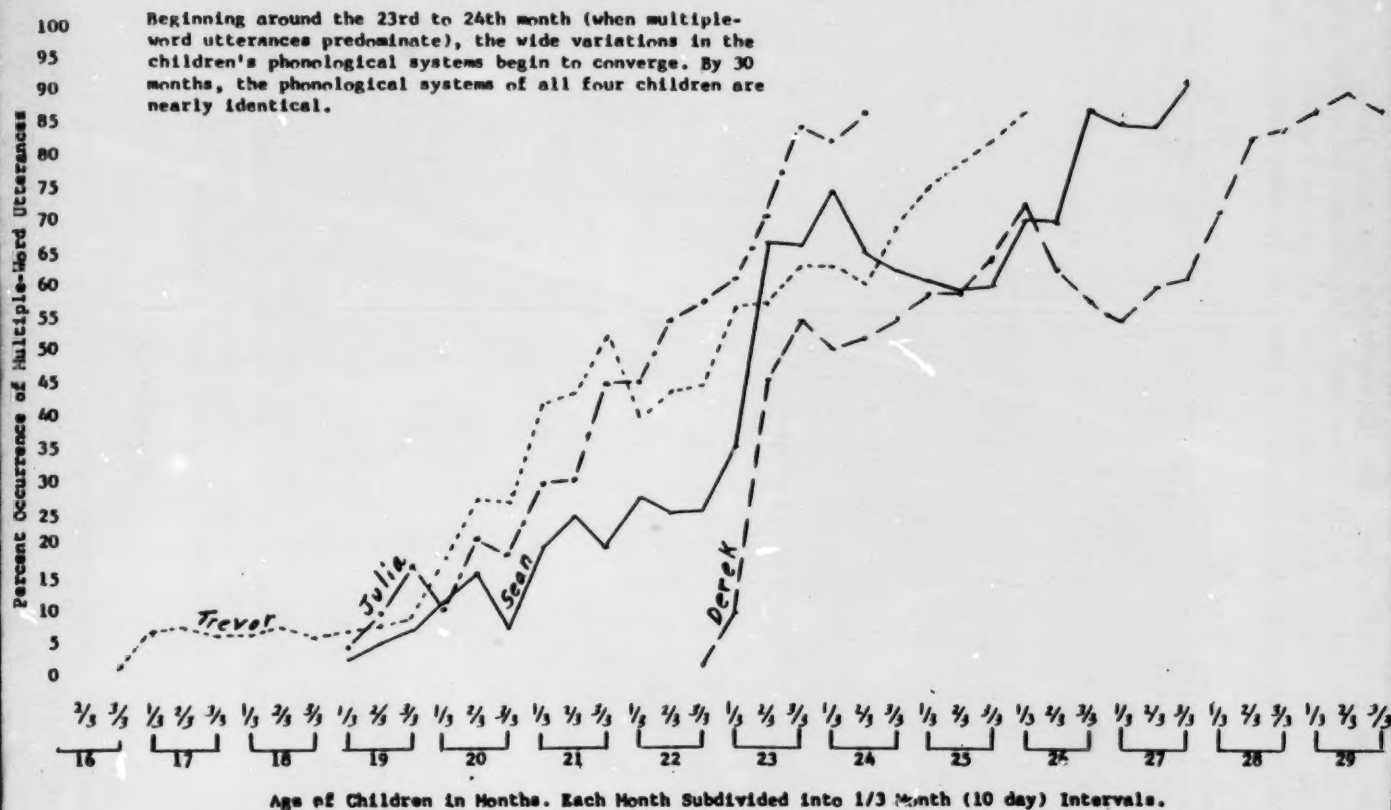
Onset and Acquisition of Multiple-Word Utterances

From Figure 1, notice that regardless of when the onset of multiple-word utterances occurs for each child, the shift from single to multiple-word utterances as a predominate speech form happens at nearly the same time for all of the children. This shift occurs quite abruptly, just prior to the second birthday, and appears to mark a major turning point in nearly every aspect of the children's language development. There is a great upward surge in vocabulary, a marked increase in the amount of talking, and the wide individual variations in syntactic and phonological development among the children begin to converge. By 30 months, the phonological systems of all four children were nearly identical. The importance of this period will also be apparent at several points later in this report.

Acquisition of Phonological Features

Particular phonological features are not blanketedly admitted into the child's phonological system at the same time or all at once; rather, they are closely tied to (or interact with) the acquisition of other features and to the phonetic environment in which they occur. This result (based on six

Figure 1
ONSET AND USE (ACQUISITION) OF MULTIPLE-WORD UTTERANCES BY FOUR CHILDREN
(Shown by % Occurrence of Multiple-Word Utterances at 1/3 Month Intervals)



children) is illustrated below showing the approximate order of acquisition of the Stop and Friction features. Observe the stops evolve first in initial-word position and then move to final position, whereas, the frictions are acquired in the reverse order. The voice/voiceless features, on the other hand, interact not only with the phonetic context but with the class or type of sounds as well. Thus, the acquisition of any given feature is not an all-or-none (or all-at-once) achievement as implied by many feature acquisition theories;

Time 1	Time 2		Time 3		Time 4		Time 5
stop+	stop+	stop+	stop+	frict+	frict+	frict+	frict+
voice-	voice+	voice-	voice+	voice-	voice+	voice-	voice+
initial+	initial+	final+	final+	final+	final+	initial+	initial+
acquisition of stops				acquisition of frictions			

Note: the above features also interact with the acquisition of place of articulation features which are omitted from this report.

Assimilation and Metathesis (results based on six children)

Assimilation (two sounds becoming alike or similar due to the influence of one on the other) Metathesis (changes in order or reversing of sounds)

These are common phonological processes varying markedly in form, depending upon 1) the stage of linguistic development, 2) the number of syllables, 3) the phonetic context, and 4) the type or class of sounds.

Assimilation (types and examples)

Progressive		Regressive	
(monosyllabic)	(polysyllabic)	(monosyllabic)	(polysyllabic)
cup [KAK]	melon [mεmε]	bike [gɛik]	cycle [Kaiki]
bus [bAP]	butter [bʌbɔ]	Mark [gAK]	window [dɛdɔ]
knife [nait]	wagon [wɛwɔ]	boom [mum]	Lorna [nonɔ]

- Assimilation declines sharply with onset of multiple-word utterances
- Assimilation influences rarely cross word boundaries
- Changes in place of articulation predominate over changes in manner
- Changes in manner of articulation almost always arise from the influence of friction or nasal consonants
- Polysyllabic - Assimilation more frequent & persistent in these words
Progressive and regressive occur with same frequency
- Monosyllabic - Regressive much more frequent than progressive
For regressive, final velar consonants /k,g,ŋ/ exert greatest influence (than non velars)

Metathesis

- Metathesis less common than assimilation and more likely to cross word boundaries - also, appears to persist longer than assimilation
- Generally, once metathesis occurs in a particular word or phrase, it persists in that same form for several weeks before dropping out
- Metathesis occurs most frequently with stop consonants ([pAk] for "cup") and in polysyllabic words ([bʌnɔt] for "button" and [gɔdi] for "doggie"), etc. There are also scattered occurrences with

consonant clusters ([gɒfæts] for "go fast"), frictions ([sɪfɪn] for "fishing"), nasals ([tʃɪkəm] for "chipmunk"), and across word boundaries in phrases ([mæfɪəplɒʃ] for "mop the floor").

Assimilation and metathesis are, perhaps, the most intriguing but least understood areas of early phonological development. They are also very short-lived processes, disappearing quite rapidly with the use of multiple-word utterances as the predominate speech form (around the 23rd to 24th month). The fact that this decrease corresponds, closely in time, to the use of multiple-word utterances is quite likely a reflection of maturational development. In other words, the children have reached a developmental stage in which they are more able to handle or process several linguistic units at the same time. This hypothesis is also supported by the relatively higher incidence of assimilations which occurred in the children's imitative responses (which are probably more taxing of their capabilities than are their own spontaneous utterances).

Anomalous Sound Changes

Anomalous and isolated sound changes sometimes arise from seemingly accidental circumstances that appear to trigger a syntactic or semantic crossover into the child's phonological system. Because of their elusive and inconspicuous origin, there are yet too few examples available to determine if the actual phonological processes underlying these "freak" sound changes are also atypical. At any rate, one of the more dramatic cases follows.

At age 16 ½ months, Trevor correctly produced the initial /h/ sound and alternated between [s] and [ʃ] for initial /s/ and /ʃ/. The family dog was named "Saltie" who Trevor called [saʔ i] or [ʃaʔ i]. These phonological patterns may be characterized as follows:

A) [h] → [h] /#_ B) [s] → [ʃ] /#_ C) [ʃ] → [ʃ] /#_ (16 ½ months)

During one of my periodic home visits, Trevor picked up the salt shaker from the table and put it in his mouth. Upon tasting the salt, he responded ha (his word for "hot" apparently because it tasted hot to him. He also apparently liked the taste, for he persisted in this practice for several weeks thereafter; each time he would grin and say ha, and each time, his mother would say, "No, Trevor, it's salt." The same day of the first incident, he began to call the family dog [haʔ] - accompanied with a mischievous grin. Three days later, he began pronouncing initial /s/ and /ʃ/ as [h] in a few words and, within two weeks, initial /s/ and /ʃ/ had nearly vanished from his speech in favor of [h] which persisted until he was about 20 months old. His phonological patterns during this period follow:

A) [h] → [h] /#_ B) [ʃ] → [h] /#_ (17 to 20 months)

This rather unusual and striking sound change appears to be semantically based, and whether changes of this sort are simply occasional phonological accidents is still unclear. However, I have included it here to illustrate the richness of child language study.

COMPUTER-ASSISTED DATA ANALYSIS

As our developmental studies have progressed, it has become increasingly clear that the sheer volume of data makes manual analysis not only impractical, but ponderous. Thus, to facilitate the analyses, we have implemented some computerization of this data. The data base will include over 30,000 utterances (approximately 60,000 words); the data for one child has already been stored in the computer.

The stored linguistic information incorporates details on initial and final consonants and consonant clusters (blends) - the primary focus of our research - as well as tags marking each utterance for reduplication, assimilation, metathesis, intervocalic consonants, "strange" vowels, and phrase context. The details of the data formats are presented in Figure 2.

Figure 2
Data Formats Illustrating a Sample of the Phonetic Data, the
Computer Entry of this Data, and the Computer Format of what
is Stored in the Computer.

1. Notebook transcription

(Julia Book II, February 6)

2424. [pɔtʰo] potato
2426. [ju ɡɾɪŋk ɪt] you drink it

- ## 2. Computer data entry

#J2 dittoed - Julia 2nd year
 IO206 dittoed - date
 2424/POTATO/P/P/ / /V/
 2426/YOU/J/J/ / /C/
 2426/DRINK/DR/GK*W/NGK/NGK/C/A/
 2426/IT/ / /T/T/C/

- ### 3. Computer formatting

J2	0206	780	2424	POTATO	P	P			V		
J2	0206	780	2426	YOU	J	J			C		
J2	0206	780	2426	DRINK	DR	GR*W	NGK	NGK	C		A
J2	0206	780	2426	IT			T	T	C		

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! - unusual
vowel
linguistic
process
A - assimilation
M - metathesis
? - strange
R - reduplication
V - intervocalic consonant
C - phrase context
reflex of final consonant
final consonant
reflex of initial consonant
initial consonant
lexical item (standard orthography)
item number in transcription notebook
age in days (computer calculated)
date (month,day)
identification (child,year)

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Two phonological studies have resulted so far from this computerized data. Both investigate how Julia acquired /stop + liquid/ clusters in initial word position. The computer-printed graph upon which these studies are based is shown below in Figure 3.

Figure 3
Suppression of /LABIAL + R/ Consonant Clusters During Acquisition
of /VELAR + R/ Clusters for Julia (19 through 26 months of age)



These studies seek to clarify the interaction between how often a sound is used in spontaneous speech and how it is phonetically realized. To do this, we find it helpful to distinguish among three types or stages of acquisition for any given sound: the lexical, the phonological, and the phonetic. When a child first begins to attempt words which, in the adult language, include the initial /kr/ cluster, for example, this is the lexical acquisition of /kr/. In phonological acquisition, the child's /kr/ begins to contrast with his initial /k/, and with any other sounds which he has phonologically acquired. (Note - the essential distinction, then, between lexical and phonological is one of non-contrastive vs. contrastive use of sounds). In phonetic acquisition, the child's phonological entity /kr/ begins to be pronounced in close approximation to phonetic [kr]. An example of these three acquisition stages is shown in Figure 4. Julia first

Figure 4
Acquisition of /STOP + R/ Clusters for Julia from 19 through 26 Months (graph derived from Figure 3)

	20m	22m	24m	
	▽	▽	▽	
/KR/	k - h - w	fw	suppression?	kw
/GR/	not acquired	w - r	gw	
/PR/	p - p ^m	suppression?		
/BR/	b	suppression?	b - b ^w	

pronounced her /kr/ words with a [k] alternating with an [h] and a [w]; this was the first stage, that of lexical acquisition. Then came phonological acquisition - she started to pronounce them as [fw] to distinguish /kr/ from her /k/ words. Then came phonetic acquisition - she started pronouncing /kr/ as [kw], which is close to the target [kr]. Note also, on the bottom line of Figure 4, that /br/ was first pronounced with a [b], and then the phonological and phonetic acquisition occurred simultaneously: the /br/ words started to be pronounced with a [b] alternating with a [b^w], which is a "w-flavored" [r].

Our preliminary studies suggest that during the overall acquisition process, each initial consonant and consonant cluster individually moves from one acquisition stage to the next; they may or may not be synchronized, either within or between natural consonant classes.¹ Thus, at any particular time, there may be an imbalance in the phonology as a whole, quite separate from the phonetic details. This imbalance influences lexical frequency and phonetic realization, as will be shown.

Acquisition of /STOP + R/ (Suppression of Phonological Forms)

Our first study study investigates fluctuations in how often a particular sound class is used in spontaneous speech. The data shows periods of time during which a child seems to suppress certain lexical items which previously had been well established. This "suppression" seems to depend

on the sounds contained in the lexical items. A similar phenomenon has been observed in the period before lexical acquisition: a child may delay starting to attempt lexical items of a certain sound class, i.e., an avoidance of selected words.² However, the "suppression" described here involves already-established sounds and lexical items.³

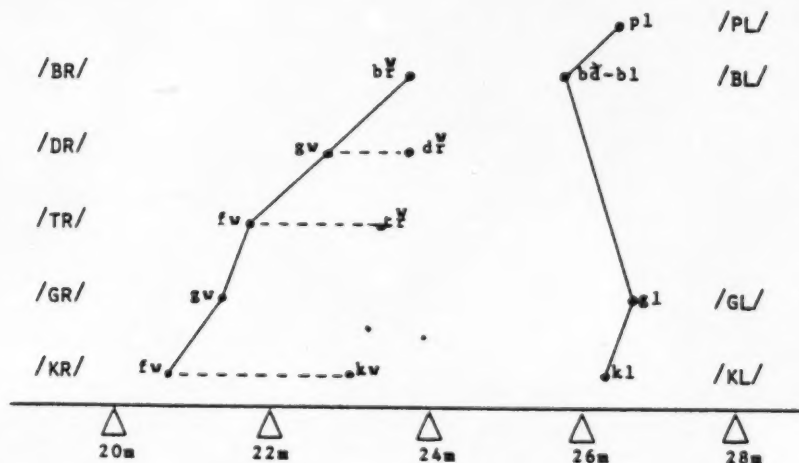
Returning to Figure 4, the stage of phonological acquisition for each labial and velar /STOP + R/ is outlined by a heavy border. Also indicated are periods of time during which certain clusters have been suppressed. This suppression appears to be related to phonological acquisitions that are occurring at the same time: when a new phonological acquisition is in progress, a potentially conflicting form is temporarily suppressed. For example, shortly after the pronunciation of /kr/ is changed from [k] to [fw], the labials start being suppressed, possibly because /pr/ and /br/ are interfering with the new [fw].

It is hypothesized that suppression is being used as a strategy of acquisition: certain sounds are suppressed even after they have been well established, as a means of facilitating sound changes elsewhere in the phonological system. This strategy appears to occur only in the early stages of language acquisition, before multiple-word utterances predominate.⁴

Acquisition of /STOP + LIQUID/ (Competing Phonological Acquisitions)

Our second study investigates the relation between time, change in acquisition stage, and phonetic realization. The data is presented in Figure 5 which includes some of the same data as in Figure 4, but re-arranged.

Figure 5
Acquisition of /STOP + LIQUID/ for Julia from 20 through 28 Months



The lines on the left of the figure are for /STOP + R/ and that on the right for /STOP + l/. The dots connected by solid lines show the beginning of phonological acquisition for each /STOP + LIQUID/ cluster. Where applicable, the dots connected by dashes show the beginning of phonetic acquisition.

The main point to be observed here is that R-clusters and L-clusters are acquired differently. R-clusters are acquired first, and their phonological acquisition gradually progresses through all the stops. It is almost as if Julia could handle the acquisition of only one /STOP + R/ cluster at a time. The L-clusters, on the other hand, are acquired later, and their phonological acquisition affects all the stops more or less simultaneously. The result is that if the two solid lines were extended upward, they would intersect just off the top of the graph. In fact, they actually do intersect: the phonological acquisition of /pr/ occurs after 30 months, so it could not be shown on the graph.

Because these two acquisitions intersect, /r/ and /l/ are acquired at about the same time for the labials, at the top of the graph - around 24-25 months. For the velars at the bottom, however, the phonological and phonetic acquisitions of /r/ are well established before those of /l/ even begin.

The labials of Figure are detailed in Figure . Two points may be observed. First, /br/ and /bl/ start their phonological acquisition at about the same time. They are both pronounced as [bʔ] for a while, and at one point, /br/ is pronounced as [bl] - in other words, /br/ and /bl/ are having difficulty remaining phonetically distinct from each other, even though both have become phonologically separated from initial /b/.

Figure 6
Acquisition of /LABIAL + LIQUID/ for Julia from 20 through 28 Months

/PL/	p - p ^h		p		pl		/PL/
/PR/	p - p ^h		p				/PR/
/BL/	b			bđ - bl		bl	/BL/
/BR/	b		b - b ^h	bđ	bđ - bl - b ^h	/BR/	
	△ 20m	△ 22m	△ 24m	△ 26m	△ 28m		

The second point to note is that /pr/ and /pl/ do remain distinct, but only because /pl/ reaches the stage of phonological acquisition. /pr/ is delayed and continues to be pronounced [p]. Thus, the labials /p/ and /b/ both behave strangely with both liquids /r/ and /l/.

It is hypothesized that the phonological acquisitions of /r/ and /l/ are competing in the /LABIAL + LIQUID/ environment. This causes erratic phonological and phonetic behavior. For /b/, the two liquids become confused and lose their distinction, so that /br/ and /bl/ merge. For /p/, the necessity to remain distinct delays the acquisition of /pr/ - possibly this delay would not have been necessary if /br/ and /bl/ had been more stable. In the field of diachronic phonology, similar "irregular" forms have been attributed to competing changes.⁵

We have presented some data on the normal acquisition of phonological features, and also some typical assimilation and metathesis processes. These have been placed within the time framework of sentence development. With computer assistance, various types of phonological behavior can be studied in detail. In particular, our computer-printed graphs are especially valuable in suggesting interesting questions, and in capturing the two-dimensional picture of a phonological and phonetic system changing through time.

FOOTNOTES

- 1 See Chen (1975) for diachronic examples of a restricted phonological change generalizing through the successive addition of phonemes undergoing the change.
- 2 Ferguson and Farwell (1975).
- 3 We have not yet established a detailed procedure for conclusively identifying periods of suppression; it is, however, necessary to start with the large data base of spontaneous speech, sampled at frequent intervals.
4. The reverse may also be true; to directly facilitate a sound change, items are added to the lexicon which contain that sound, and these lexical items are used more frequently. We suspect this happens during phonological acquisition. See Wang (1969) for a discussion of how the lexicon may influence diachronic change.

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